

Two Species of Notodelphyid Copepods (Cyclopoida) Associated with Ascidiens in Korea

In-Soon Seo and Boon-Jo Rho*

(Ecosystem Conservation Division, Ministry of Environment, Kyönggi-Do, 427-760; *Department of Biological Science, Ewha Womans University, Seoul 120-750, Korea)

ABSTRACT

Two species of notodelphyid copepods, *Doroixys uncinata* Kerschner, 1879 and *Doropygus rigidus* Ooishi, 1962 are redescribed on the basis of the specimens taken from the ascidiens deposited at the Department of Biological Science, Ewha Womans University. The former species were taken from the test of the compound ascidian *Aplidium glabrum* (Verrill), and the latter from the body cavity of the solitary ascidiens *Cnemidocarpa irene* (Hartmeyer) and *Styela tokiokai* Nishikawa.

Key words: Notodelphyid Copepods, *Doroixys*, *Doropygus*, Ascidiens, Korea.

INTRODUCTION

The genus *Doroixys* Kerschner, 1879 belonging to the family Notodelphyidae Dana, 1853 has been poorly known, and only two species have been described until now: *Doroixys uncinata* Kerschner, 1879 and *Doroixys minuta* Stock, 1970. The genus has several characters in common with three other genera (*Demoixys*, *Mesoixys* and *Prophioseides*), such as reduced appendages, modified body, and small body. The species of *Doroixys*, however, characteristically have well-developed antennules, antennae, legs 1-4, caudal rami, pointed process on the lateral sides of cephalosome and prominent rostrum. *D. uncinata* has been recorded from several compound ascidiens mainly of the suborders Aplousobranchiata and Stolidobranchiata in Mediterranean, northern coast of France and Japan (Illg, 1958; Ooishi, 1972). Korean specimens of these copepods were taken from the compound ascidian of the genus *Amaroucium*. *D. minuta* Stock, 1970 has been recorded from the *Didemnum* sp. of the suborder Aplousobranchiata collected at Puerto Rico

Island located in the West Indies.

Seo and Lee (1997) reported two Korean copepod species of the genus *Doropygus*: *D. hoi* Seo and Lee, 1997 and *D. pinguis* Ooishi, 1962. Until now Korean notodelphyid copepods associated with ascidians have been known of six species in the five genera (*Doropygus*, *Paranotodelphys*, *Pachypygus*, *Lonchidiopsis*, and *Botryllophilus*) by Seo and Lee (1995a, b, 1996, 1997). In the present study, two other notodelphyid copepods each belonging to genera *Doroixys* and *Doropygus* from the South Sea and the East Sea in Korea are newly added to Korean fauna.

The copepod specimens were taken from the test of the compound ascidian (Policlinidae) with dissecting needles, or from the body cavity of the solitary ascidians (Styelidae) which was cut along the median plane with scissors and then were filtered for copepods with a small net (mesh No. 32). Filtered copepods were preserved in 70% ethanol. Dissections were carried out in lactic acid added with the lingnin pink stain. Semi-permanent preparations of these dissections were made in lactophenol as mounting medium and were sealed with arabic gum. Illustrations were made with the drawing tube. The copepod specimens are deposited in the Department of Biological Science, Ewha Womans University.

Family Notodelphyidae

Genus *Doroixys* Kerschner, 1879

***Doroixys uncinata* Kerschner, 1879 (Figs. 1-3)**

Doroixys uncinata Kerschner, 1879 (p. 176, figs. 11-13); Canu, 1892 (p. 83, figs. 1-14); Illg, 1958 (p. 484); Illg and Dudley, 1965 (p. 376); Dudley and Solomon, 1966 (p. 314); Ooishi, 1972 (p. 305, figs. 1-3).

Material Examined. 5 ♀♀ collected from the compound ascidian, *Aplidium glabrum* (Verrill, 1871) at Sögwip'o in Cheju Island, 9 Feb. 1971, collected by Boon-Jo Rho.

Female. Body (Fig. 1B) 1.93 mm (from tip of cephalosome to end of caudal ramus), small, compressed, and consists of cephalosome, metasome and urosome. Body covered with minute hairs. Cephalosome protruded at postero-lateral corner into a pointed process on each side. Rostrum large and longer than wide, covered with minute hairs. Metasome distinctly 4-segmented; first 3 segments of relatively moderate size, whereas last one posteriorly inflated to enclose a brood pouch. Embryos in brood pouch relatively large, and 13 in number. Urosome 5-segmented. Articulation between metasome and urosome distinct. First urosomal somite with genital apparatus on ventral margin. Anal somite bearing caudal rami.

Antennule (Fig. 1A) 8-segmented, covered with minute hairs, gradually tapered: two proximal segments expanded, larger than rest segments combined together. Setal formula: 2, 9, 3, 2, 2, 9. These setae all simple.

Antenna (Fig. 1G) 3-segmented. Proportional lengths of segments from basal to apical as long as. Basal 2 segments unarmed, terminal segment with 1 short seta near middle of outer margin, 1 curved hook and 1 short seta at apex and 1 short seta on distal part.

Mandible (Fig. 2A) consisting of coxa and rami. Medio-distal margin of coxa with 5 teeth graded in size, a row of closely set tiny setules and 2 proximal setules. Basis with 1 medial seta. Endopod 2-segmented: first with 1 medial seta, distal segment with 2 medial and 3 apical setae. Exopod with 5 long setae on apical margin.

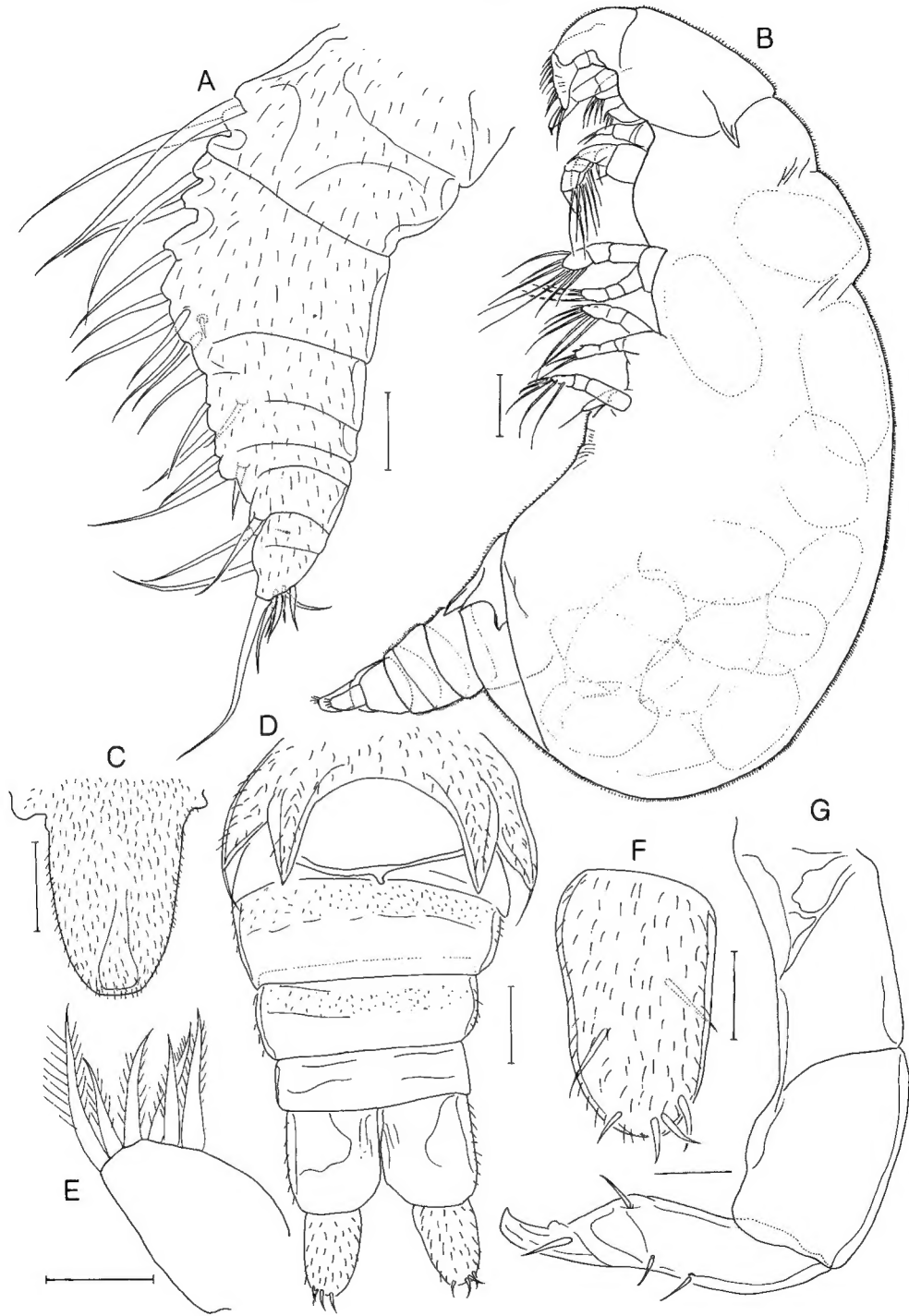


Fig. 1. *Doroixys uncinata* Kerschner, 1879, female: A, antennule; B, habitus, lateral; C, rostrum; D, urosome, ventral; E, maxilliped; F, caudal ramus; G, antenna. Scales: A, E-G = 0.02 mm; B = 0.03 mm; C, D = 0.05 mm.

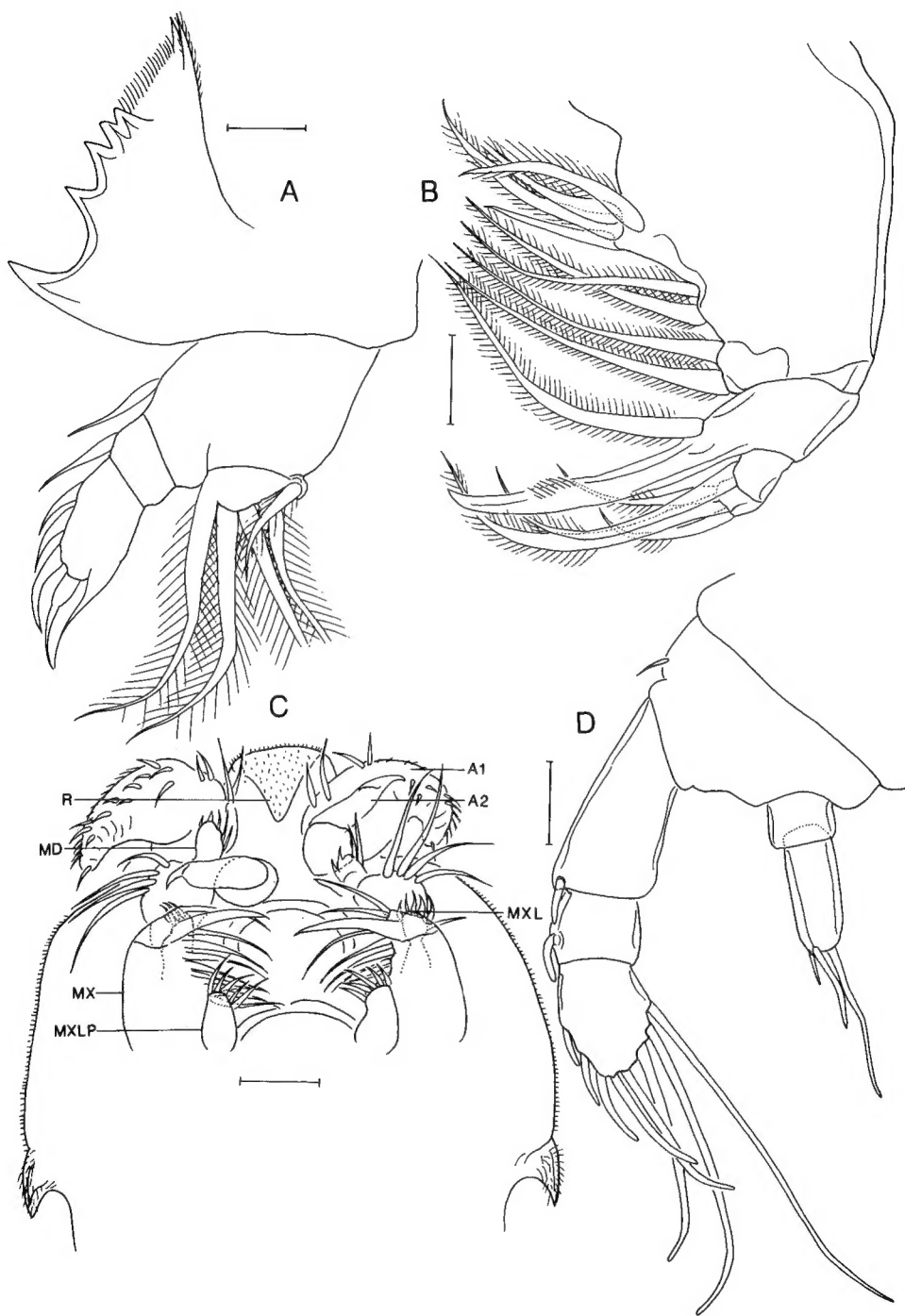


Fig. 2. *Doroixys uncinata* Kerschner, 1879, female: A, mandible; B, maxilla; C, anterior part of cephalosome, ventral; D, leg 4. Scales: A, B = 0.02 mm; C = 0.05 mm; D = 0.03 mm.

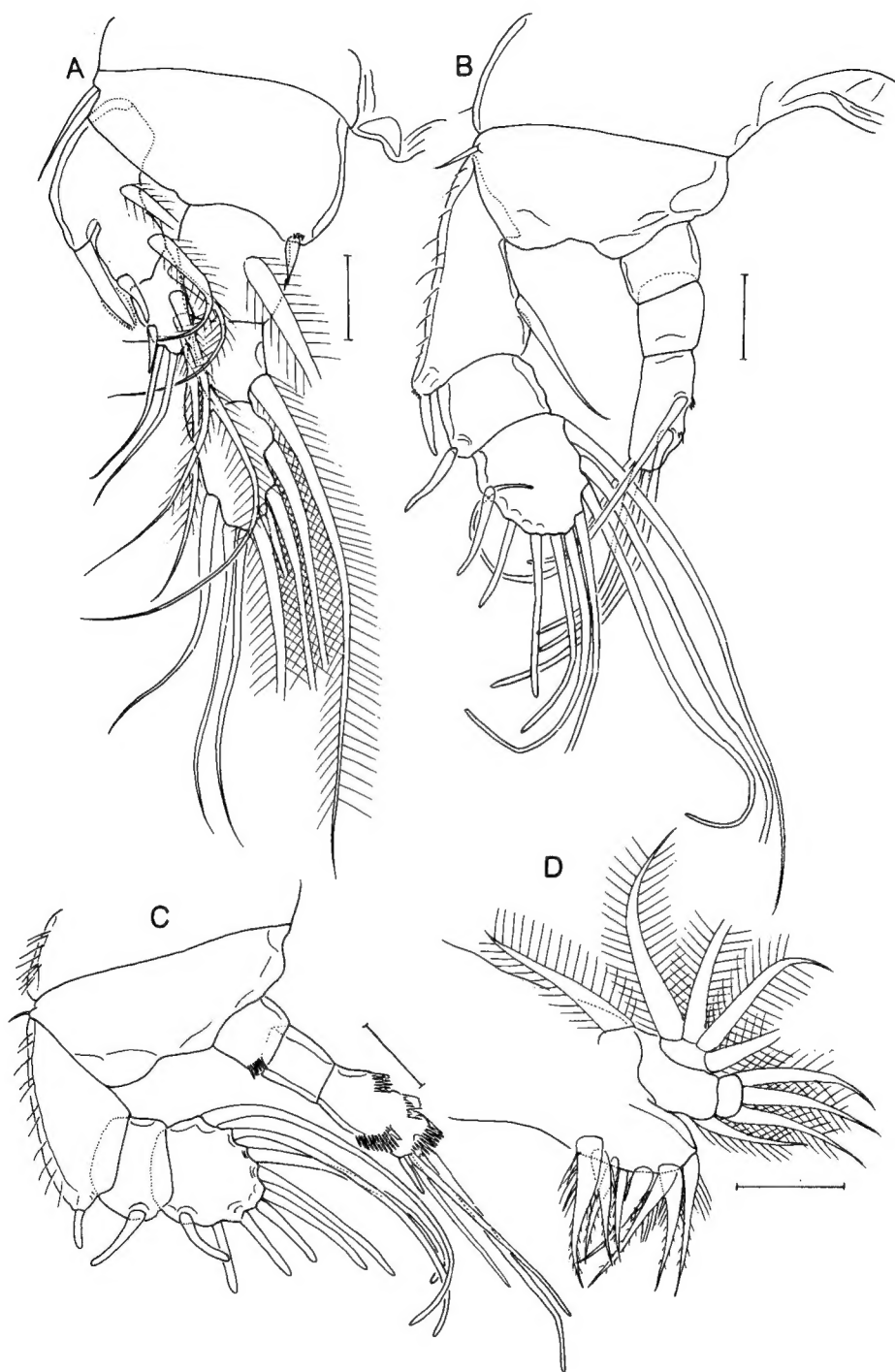


Fig. 3. *Doroiixys uncinata* Kerschner, 1879, female: A, leg 1; B, leg 2; C, leg 3; D, maxillule. Scales: A - C = 0.03 mm; D = 0.02 mm.

Maxillule (Fig. 3D) 2-segmented protopod and non-segmented rami. Epipod with 1 stout seta. Coxa bearing 6 setae on medial margin. Basis with 1 seta at medio-distal corner. Endopod and exopod with 3 short and 4 long setae respectively. Setae on rami all plumose.

Maxilla (Fig. 2B) consisting of 4 segments. Basal segment broader and larger than rest segments combined together, consisting of 4 setiferous endites. Basal endite with 3 setae; second with 1 seta; third and fourth with 2 setae, respectively. Second segment with 1 long, heavy, falcate process, whose base with 1 long seta. Third segment with 1 long medial seta. Fourth segment with 1 long and 2 middle terminal setae. All setae plumose.

Maxilliped (Fig. 1E) consisting of simple lobe, with 3 apical and 3 distal plumose setae.

Swimming legs 1-4 (Fig. 2D; 3A-C) consisting of 2-segmented protopodite and 3-segmented rami except for endopod of leg 4. Exopod of legs 2-4 longer than endopod.

Formula of spines (Roman numerals) and setae (Arabic numerals) as follows:

Leg 1 prp 0-0; 1-I	Exp I-1; I-1; I-6
	Enp 0-1; 0-1; 7
Leg 2 prp 0-0; 1-0	Exp I-1; I-0; 9
	Enp 0-0; 0-0; 5
Leg 3 prp 0-0; 1-0	Exp I-0; I-0; 9
	Enp 0-0; 0-0; 4
Leg 4 prp 0-0; 1-0	Exp I-0; I-0; 8
	Enp 0-0; 3

Leg 5 divided into 2 pointed lobes. These lobes covered with minute hairs. Outer lobes with 1 apical seta, respectively.

Caudal ramus shorter than anal segment, about 2 times as long as its own width and with 4 apical setae.

Remarks. The present specimens of *Doroixys uncinata* Kerschner, 1879 is very similar to the Japanese specimens in characters. All copepod specimens from the Korea and Japan were taken from the compound ascidian, *Amaroucium glabrum* Verrill, 1871. The present species is similar to *Doroixys minuta* Stock, 1970 in the following characters: 1) small body length, 2) cephalosome consisting of pointed process on each side, 3) well-developed legs 1-4.

Genus *Doropygus* Thorell, 1859

***Doropygus rigidus* Ooishi, 1962 (Figs. 4-6)**

Doropygus rigidus Ooishi, 1962 (p. 20, figs. 7, 8)

Material Examined. 6 ♀♀ collected from *Styela tokiokai* Nishikawa, 1991, at Sögwip'o in the Cheju Island, 7 Aug. 1970, Boon-Jo Rho; 1 ♀ from *Cnemidocarpa irene* (Hartmeyer, 1906), at Sögwip'o in Cheju Island, 13 Apr. 1975, Boon-Jo Rho; 1 ♀ from *Styela tokiokai*, Nishikawa 1991, at Tongyöng in the South Sea, 5 June 1978, Boon-Jo Rho and Jun-im Song; 3 ♀♀ from *Cnemidocarpa irene* (Hartmeyer, 1906), at Söngsanp'o in Cheju Island, 9 July 1986, Jun-im Song and Suk-Jung Yun; 10 ♀♀ from *Styela tokiokai* Nishikawa, 1991, at Kōje Island in the South Sea, 8 July, 1996, Boon-Jo Rho; 4 ♀♀ from *Styela tokiokai* Nishikawa, 1991, at Kōje Island in the South Sea, 8 July 1996, Boon-Jo Rho; 6 ♀♀ from *Styela tokiokai* Nishikawa, 1991, at Kōje Island in the South Sea, 9 July, 1996, Boon-Jo Rho; 3 ♀♀ from *Styela tokiokai* Nishikawa, 1991, at Kōje

Island in the South Sea, 29 Jan. 1997, Boon-Jo Rho; 3 ♀♀ from *Styela tokiokai* Nishikawa, 1991, 2 Feb. 1997, at Dangsa in the East Sea, Boon-Jo Rho.

Female. Body 3.67 mm (from tip of cephalosome to end of caudal rami, except terminal setae). Body form variable from compressed to depressed, and with highly chitinized tergites. Cephalosome and second to third metasomal somites with well-defined pleura, which consisting of thick marginal ridge. Cephalosome with lateral process on both sides. Metasome distinctly 4-segmented. Urosome distinctly 6-segmented, relatively slender.

Antennule (Fig. 5B) 9-segmented: basal two segments elongate and distal 7 segments short and slender. Setal formula: 3(2 plumose), 15(4 plumose), 5(1 plumose), 5(1 plumose), 4(1 plumose), 4(1 plumose), 2, 3, 8+1 aesthete. Simple and plumose setae mixed.

Antenna (Fig. 4E) 3-segmented and slender. Proportional lengths 1.7 : 1 : 1.7. Basal two segments each with 1 distal seta on dorsal margin. Third segment with 1 clawed hook, 3 curved setae, 1 distal plumose setae, 4 feeble, short setae on terminal part.

Mandible (Fig. 5E) consisting of coxa, basis and rami. Masticatory lamella of coxa with 4 major teeth, a row of set denticles and 2 proximal setules. Basis broad, with 1 distal seta on medial margin. Endopod 2-segmented: first segment wider than long, with 4 setae on medial margin; second one elongate, two times as long as wide, and with 10 setae. Exopod unimerous, elongate, and with 5 long marginal setae.

Maxillule (Fig. 4A) consisting of 2-segmented protopodite and 1-segmented rami. Major endite of coxa with 9 graded setae on medial margin. Epipodite with 1 tiny and 1 long seta. Basipodite with 3 setae. Secondary endite with 1 setiform. Endopod with 3 long setae. Exopod with 4 subequal setae.

Maxilla (Fig. 5F) narrow, 5-segmented. Basal segment about as long as remaining segments combined together, with 4 endites; first endite with 3 long setae; second with 1 seta; third with 2 setae and fourth with 2 setae and 1 tiny seta. Second segment with 1 tiny and 2 long setae. Third and fourth segments with 1 long seta, respectively. Fifth segment with 3 terminal setae and 1 short proximal seta.

Maxilliped (Fig. 4C) 2-segmented. Basal segment quadrate and with 9 setae forming 2 groups of 4 proximal and 5 distal setae. Terminal segment short, with 2 long setae.

Leg 1 (Fig. 6A) consisting of bimerous protopodite and 3-segmented rami.

Legs 2-4 (Fig. 6B-D) consisting of bimerous protopodite and endopod, and 3-segmented exopod. Rami of legs 1-4 slender. Endopod as long as exopod, but endopods of legs 2 and 3 longer than exopod.

Formula of spines (Roman numerals) and setae (Arabic numerals) as follows:

Leg 1 prp 0-1; 1-1	Exp: I-1; I-1; IV, 4
	Enp: 0-1; 0-1; 6
Leg 2 prp 0-1; 1-0	Exp: 1-1; 1-1; 9
	Enp: 0-1; 8
Leg 3 prp 0-1; 1-0	Exp: 1-1; 1-1; 9
	Enp: 0-1; 8
Leg 4 prp 0-1; 1-0	Exp: 1-0; 1-1; 8
	Enp: 0-1; 7

Leg 5 (Fig. 5C) consists of 2 segments, proportional lengths 1 : 1.8. Second segment with 1 distal

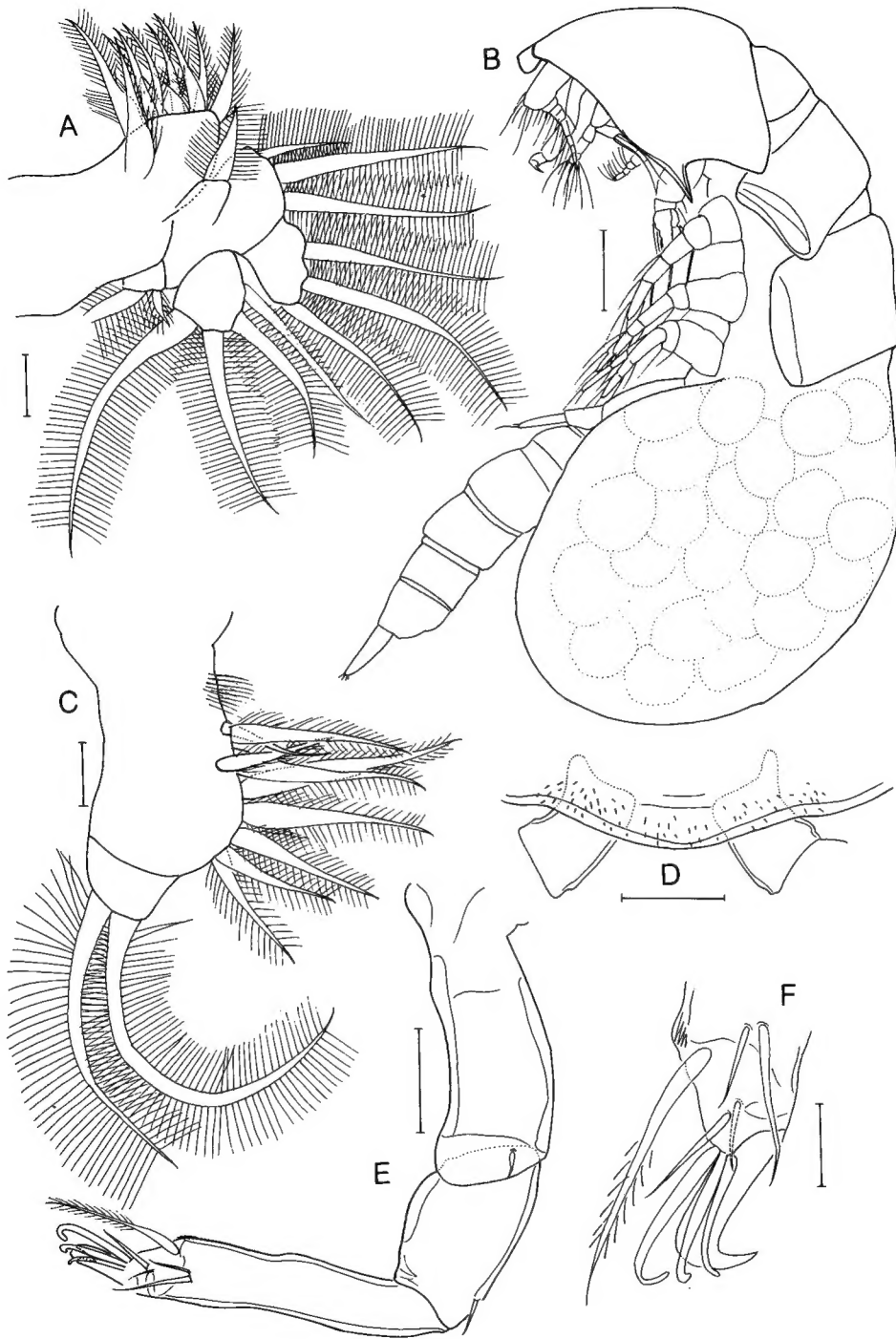


Fig. 4. *Doropygus rigidus* Ooishi, 1962, female: A, maxillule; B, habitus, lateral; C, maxilliped; D, rostral area; E, antenna; F, distal part of antenna. Scales: A, B, C, E = 0.02 mm; D = 0.1 mm; F = 0.05 mm.

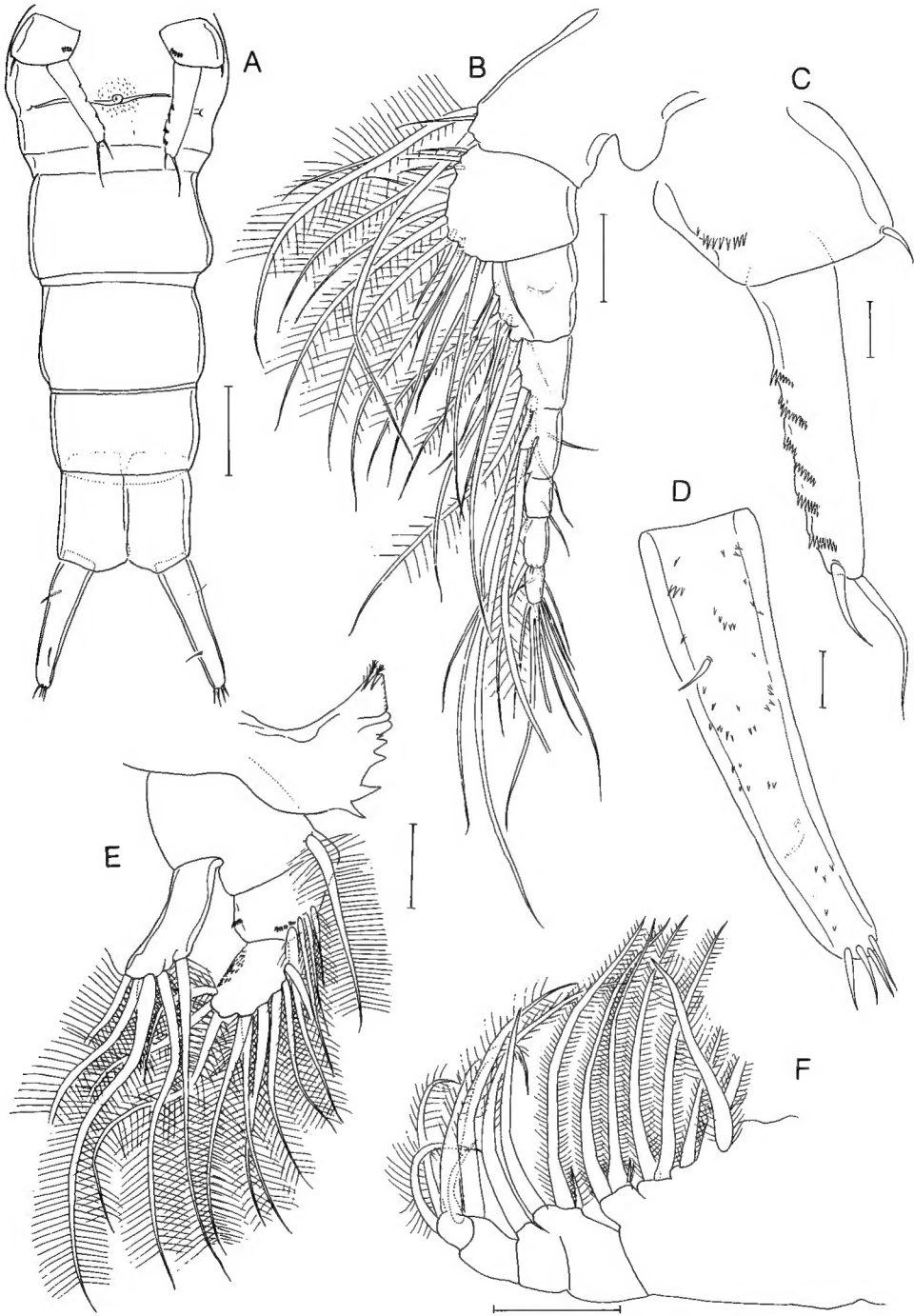


Fig. 5. *Doropygus rigidus* Ooishi, 1962, female: A, urosome, ventral; B, antennule; C, leg 5; D, caudal ramus; E, mandible; F, maxilla. Scales: A = 0.1 mm; B, E, F = 0.05 mm; C, D = 0.02 mm.

and 1 long terminal seta, and 4 rows of denticles on median side.

Caudal rami (Fig. 5D) long, with 4 minute terminal setules, and with 1 proximal and 1 distal seta on ventral and dorsal margins.

Remarks. The Korean specimens of *Doropygus rigidus* Ooishi, 1962 closely resemble Japanese ones in the morphologies of mandibles, maxillae, maxillipeds, and legs 1-5, but are slightly different from the latter in the number of setation of the first and second segments of antenna.

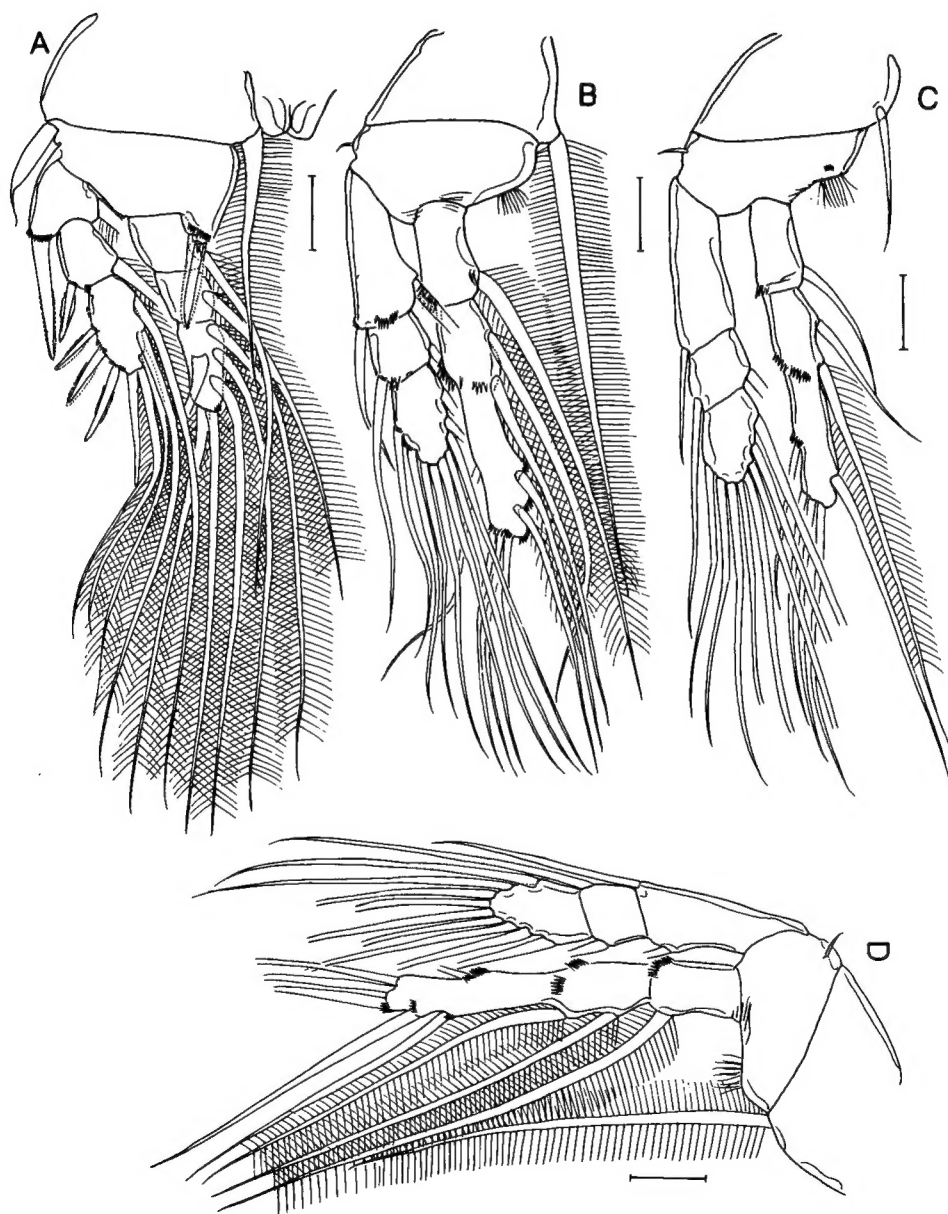


Fig. 6. *Doropygus rigidus* Ooishi, 1962, female: A, leg 1; B, leg 2; C, leg 4; D, leg 3. Scale: A-D = 0.05 mm.

ACKNOWLEDGEMENTS

The present study was supported from the Korea Research Foundation as a Post-Doc. Research Programme, partly from the Basic Science Reaserch Institute Program, Korean Ministry of Education through Reaserch Fund (BSRI-96-4421).

REFERENCES

- Canu, E., 1892. Les Copépodes du Boulonnais: morphologie, embryologie, taxonomie. Trav. Lab. zool. marit. Wimereux **6**: 1-354.
- Dudley, P.L. and D.N. Solomon, 1966. *Pythodelphys acurris*, a new genus and species of copepoda (Notodelphyidae) from the Pacific Ocean. Crustaceana, **11**(3): 314-320.
- Illg, P.L., 1958. North American copepods of the family Notodelphyidae. Proc. U.S. Nat. Mus., **107**: 463-649.
- Illg, P.L. and P. L. Dudley, 1965. Notodelphyid copepods from the vicinity of Naples. Publ. Staz. Zool. Napoli, **34**: 373-451.
- Kerschner, L., 1879. Über zwei neue Notodelphyiden nebst Bemerkungen über einige Organisation-sverhältnisse dieser Familie. Denkschr. math.-naturw. Cl. K. Akad. Wiss., Wien, **41**: 155-196.
- Ooishi, S., 1962. Four species of notodelphyoid copepod newly found in Japan. Rep. Fac. Fish. Pref. Univ. Mie, **4**: 7-25.
- Ooishi, S., 1972. Notodelphyid copepods associated with compound ascidians in Akkeshi Bay, Japan. Publ. Seto Mar. Biol. Lab., **19**: 303-326.
- Seo, I.S. and K. S. Lee, 1995a. Copepod associated with ascidians from Korea. I. A new record of notodelphyid (Copepoda, Cyclopoida) species from ascidians in the East Sea, Korea. Korean J. Zool., **38**: 299-304.
- Seo, I.S. and K.S. Lee, 1995b. Copepod associated with ascidians from Korea II. A new species of *Botryllophilus* (Copepoda, Cyclopoida, Ascidicolidae) from simple ascidians at Chindo Island in the South Sea, Korea. Korean J. Syst. Zool., **11**: 79-86.
- Seo, I.S. and K.S. Lee, 1996. Two species of Notodelphid Copepoda (Cyclopoida) associated with solitary ascidian (Tunicata) in Korea. Korean J. Syst. Zool., **12**(4): 289-304.
- Seo, I.S. and K.S. Lee, 1997. *Doropygus hoi*, a new species, and redescription of *Doropygus pinguis* Ooishi, 1962 (Copepoda, Cyclopoida, Notodelphyidae) associated with solitary ascidians in Korea. Korean J. Biol. Sci., **1**: 553-563.
- Stock, J.H., 1970. Notodelphyidae and Botryllophilidae (Copepoda) from the West Indies. Stud. fauna Curaçao and other Caribb Isl., **34**: 1-45.

RECEIVED: 17 March 1998

ACCEPTED: 17 April 1998

해초류에 공생하는 한국산 요각류 2종

서 인 순 · 노 분 조*

(환경부 생태계조사단실, *이화여자대학교 생물학과)

요 약

이화여자대학교 생물학과에 보관중인 해초류(피낭류)로부터 요각류 2미기록종이 발견되어 재기재하였다. 이 중에서 *Doroixys uncinata* Kerschner, 1879는 만두멍게과에 속하는 군체멍게인 미끈만두멍게(*Aplidium glabrum* (Verrill, 1871))의 test로부터 발견되었고, *Doropygus rigidus* Ooishi, 1962는 미더덕과에 속하는 단체멍게인 유두멍게(*Cnemidocarpa irene* (Hartmeyer, 1906))와 세줄미더덕(*Styela tokiokai* Nishikawa, 1991)의 새낭에서 발견되었다.